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INSTITUTE

Tyndall Centre
for Climate Change Research

Grantham Institute
for Climate Change

AVOID is a UK research programme funded by DECC/Defra and led by the Met Office in a consortium with the Walker Institute, Tyndall Centre and Grantham Institute.

DEPARTMENT OF ENERGY & CLIMATE CHANGE

defra
Department for Environment Food and Rural Affairs

Living With Environmental Change

Can we avoid dangerous impacts?

Avoiding the most serious climate change impacts will require informed mitigation policies. This requires information about emission reductions, the impacts that can be avoided and the total cost.

KEY FINDINGS

- **Stringent mitigation action** to limit warming to 2 °C avoids a large amount of the climate impacts that would otherwise occur in the 21st century. However, since even this stringent action will not avoid all climate change impacts, significant damage or adaptation costs will still occur but they will be much reduced compared with business as usual (SRES A1B).
- Some **benefits** of mitigation policy will be realised by the 2050s. The benefits will continue to increase in the second half of the century.
- Reducing the risk of triggering **accelerated or irreversible climate change** is one of the strongest reasons for imposing stringent climate mitigation policies. Limiting future climate change leads to a lower probability of irreversible melting of the Greenland and Antarctic ice-sheets and the release of large natural stores of methane from under parts of the ocean, which could cause further warming. It will also limit the dieback of tropical forests.
- For impacts during the 21st century, achieving an **early peak** in global emissions leads to greater avoided impacts on many sectors later in the century.
- Some impacts depend on both temperature and CO_2 concentration. For example, in our agricultural model a higher CO_2/non-CO_2 ratio typically benefits agriculture in the short-term. In the longer term, this benefit may be outweighed by negative impacts on agriculture due to the continuing rise in temperature and changes in rainfall. Furthermore, higher CO_2 concentrations will also lead to greater ocean acidification, damaging coral reefs.
- There is a significant **regional variation** of avoided impacts (and remaining impacts). However, some impacts will be felt **non-locally** because of global trade, migration and potential international conflicts over fertile land and access to water.

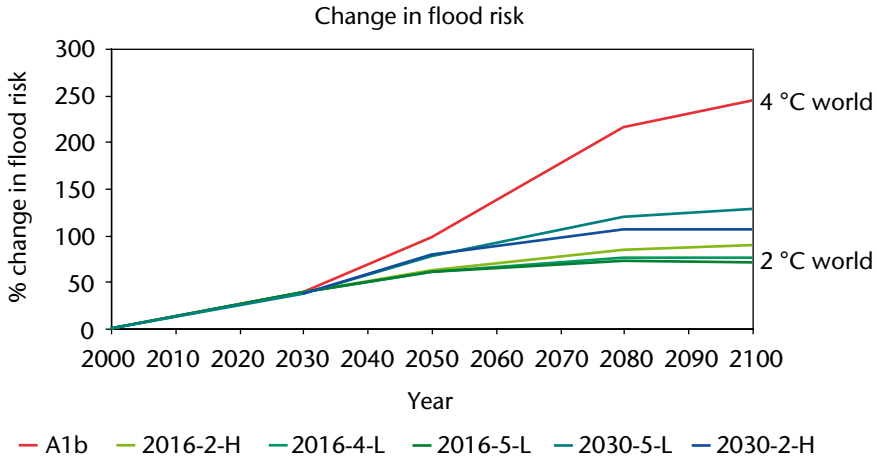
CALCULATING AVOIDED IMPACT

The AVOID[1] programme has modelled the climate change impacts that can be avoided by taking mitigation action to reduce emissions instead of following a business as usual path (A1B) for a number of sectors including food security, agriculture, water resources, human health, biodiversity and coastal systems.

A subset of five mitigation scenarios from the full 150 AVOID scenarios were used in this impacts investigation. The AVOID impacts scenarios use emissions that peak in 2016 or 2030, decrease at a rate of 2% or 5%, and have two different long-term emissions levels. The results presented here are based on patterns from the HadCM3 climate model, but the general conclusions are also valid for patterns from alternative climate models.

"Can nine billion people be fed? Can we cope with the demands in the future of water? Can we provide enough energy? Can we do all that while mitigating and adapting to climate change?"

Prof. John Beddington, UK Chief Scientist



Global change in fluvial flood risk for a 'business as usual' scenario (SRES A1B) and five mitigation scenarios (2016-2-H, 2016-4-L, 2016-5-L, 2030-5-L and 2030-2-H). For example, for 2016-5-L, the emissions peak in 2016 before reducing by 50% per year until a low emissions floor is reached.

WATER — RESOURCES AND FLOODING

Water resources

The regions with greatest avoided water stress are in Central America, Africa (North, South and East) and in Europe. Benefits are also seen in the Middle East, India and the US.

Fluvial flooding

Mitigation reduces, but does not eliminate, the impact of climate change on global exposure to flood risk, with little effect before 2050 (see graph on the left). Most fluvial flood-related impacts are in south and east Asia.

Coastal systems

Cuts in emissions will reduce the number of people experiencing coastal flooding by 2050, and the benefits are substantial by 2100, assuming no adaptation. However, mitigation will only delay (to the 22nd or 23rd century) rather than avoid 21st century flood impacts due to the inertia in sea-level rise. This delay has the benefit of reducing adaptation costs. Stringent mitigation also reduces the risk of irreversible melting of Greenland and Antarctic ice-sheets. Hence, for sea-level, mitigation is able to reduce sea-level rise to manageable rates but adaptation is still required to avoid coastal impacts.

1 Avoiding Dangerous Climate Change.

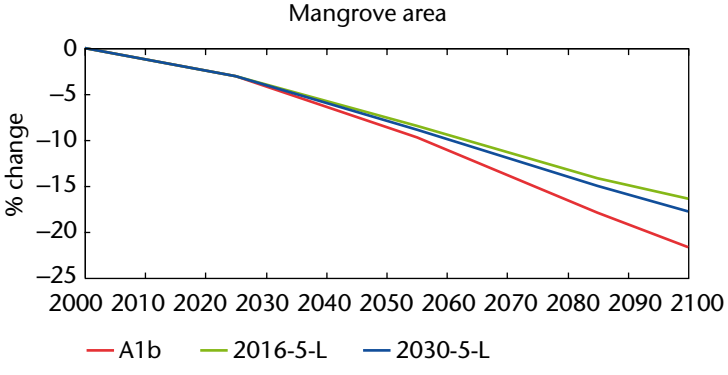
ENVIRONMENT — ECOSYSTEMS AND BIODIVERSITY

Biodiversity
Mitigation reduces the number of species which are at risk of extinction from climate change. For example, in Europe, by 2080 a mitigation scenario peaking in 2016 reduces the number of endangered mammals from 25 to six.

Wetlands
Coastal wetlands respond to sea-level rise by migrating inland, accreting vertically, or transitioning to other types of wetland. In the absence of mitigation policy, and assuming evolving coastal defences constraining wetland migration, sea-level rise would lead to a loss of approximately 20% of global mangroves by the end of the century. Mitigation scenarios with emissions peaking in 2016 or 2030 slow this loss to around 15% (see graph below).

Land ecosystem
Mitigation slows the rate of change, but does not prevent major ecosystem productivity changes. For example, the Amazonian rain-forest has some loss at 2 °C, but the loss is much greater in a business as usual 4 °C world.

The habitat suitable for the *Mustela ermine* in Europe is considerably reduced by the end of the century to pockets in Scotland, Northern Ireland and Norway and Sweden due to climate change. Mitigation sees these species staying in England, Denmark and the Alps.



Global change in mangrove area

AGRICULTURE AND FOOD

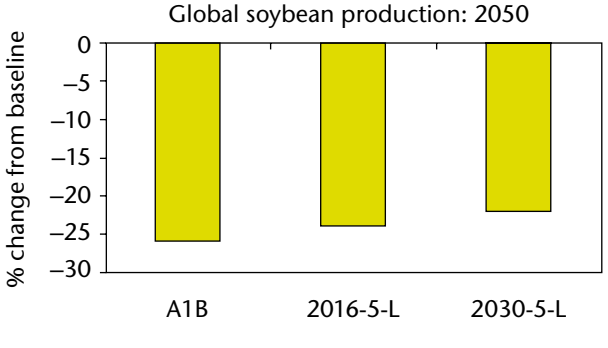
Land suitability
The suitability of land for cultivation depends upon climate, topography and soil properties. Climate change tends to increase land suitable for cultivation at high latitudes (due to higher temperatures), but decreases suitability in many dry, tropical and subtropical regions (due to lower moisture availability).

Climate mitigation reduces the effect of climate change on land suitability. For example, early reduction of emissions decreases the area which becomes unsuitable by over 60% by 2080.

Food production
The effects of climate mitigation on food production have been calculated for soybean, a major global crop used for producing both protein and oil.

Climate change leads to a reduction in soybean yield and production. Mitigation reduces this decrease in production slightly (see graph below).

The consequences of climate mitigation on production reflect a complex relationship between climate change and CO_2 concentration. For example, avoided impacts for 2050 are greater when emissions peak in 2030 compared to a peak in 2016. This is because the balance between the effects of CO_2 fertilisation and increased temperature is favourable for soybean growth. At the end of the century, the percentage of avoided impacts is greater than at 2050.

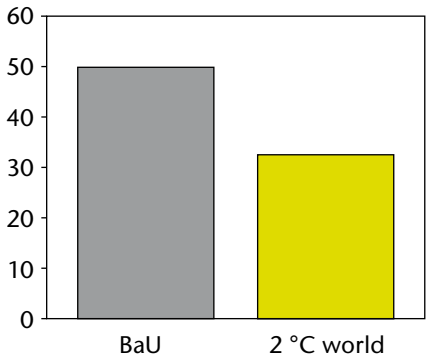


Global soybean production for 2050, assuming no explicit adaptation to climate change

GLOBAL BENEFITS OF EARLY MITIGATION BY 2100

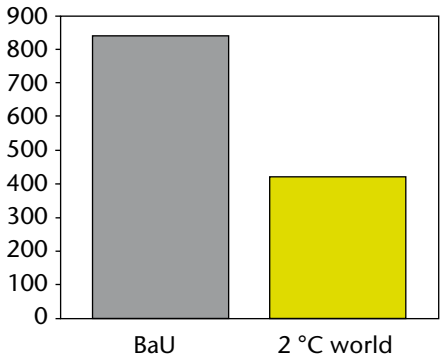
A large fraction of the global impacts in 2100 can be avoided. In the graphs below, the grey bar represents an unmitigated world that reaches 4 °C by 2100, while the green bar shows the impacts at 2100 for a world in which early and rapid mitigation limit warming to 2 °C by 2100.

Decrease in crop suitability, as a % of cropland



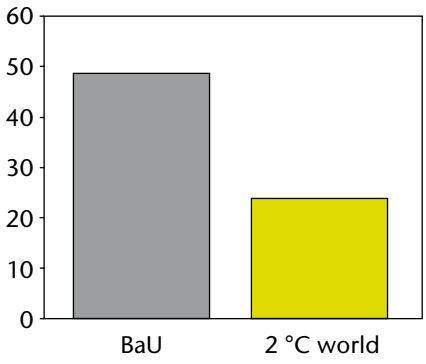
Global benefits of early mitigation by 2100 for crop suitability.

Millions of people that experience increase in water stress



Global benefits of early mitigation by 2100 for water stress.

Percentage of flood-prone population exposed to increase in flood hazard



Global benefits of early mitigation by 2100 for fluvial flood hazard.

For more information on the scientific content of AVOID, contact:
Dr Jason Lowe, Chief Scientist for AVOID, Met Office Hadley Centre, UK
Email: avoid-chiefsci@metoffice.gov.uk Tel: +44 (0)118 378 5612

For more information on how to join AVOID, contact:
Dr Jolene Cook, Programme Officer for AVOID, DECC, UK
Email: jolene.cook@decc.gsi.gov.uk Tel: +44 (0)300 068 5589

To receive updates on the AVOID programme:
Email: avoiding@metoffice.gov.uk

Met Office
FitzRoy Road, Exeter
Devon, EX1 3PB
United Kingdom

Tel: 0870 900 0100
Fax: 0870 900 5050
enquiries@metoffice.gov.uk
www.metoffice.gov.uk

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